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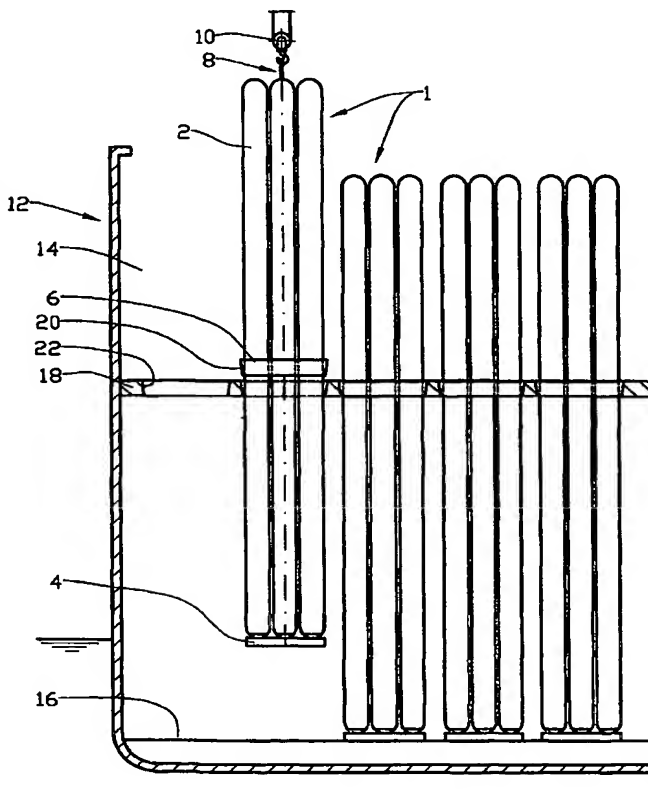
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(54) Title: **A DEVICE FOR AND A METHOD OF FIXING AND LIFTING VERTICALLY INSTALLED CARGO PRESSURE TANKS IN SHIPS**



(57) Abstract: A device for and method of fixing vertically installed cargo pressure tanks (2), particularly the type used for sea transport of pressurised petroleum products, wherein at least two cargo pressure tanks (2) constitute a liftable cassette (1), the tanks (2) of which preferably are placed in the upright position on a cassette lifting frame (4) and are interconnected by means of a guide frame (6).

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A DEVICE FOR AND A METHOD OF FIXING AND LIFTING VERTICALLY
INSTALLED CARGO PRESSURE TANKS IN SHIPS

This invention regards a device for and a method of fixing and lifting vertically installed pressure tanks in ships. In particular, it regards vertically installed pressure tanks, in which two or more pressure tanks are arranged in a cassette, and in which the cassette is arranged to be lifted out of and into the ship's cargo hold.

Sea transport of gaseous petroleum products essentially has taken place by means of the so-called Liquefied Natural Gas (LNG) method. The method comprises cooling of gas to a liquid state, whereupon the gas may be transported in ship tanks at atmospheric pressure. The method requires costly equipment both at the shipment and receiving locations. As the gas must be cooled to a relatively low temperature, up to a fifth of the gas is used to operate the cooling and heating processes. Consuming this amount of energy solely in transport-related processes is expensive and also environmentally questionable.

Several other ship-based solutions have been proposed, in which the gas is pressurised and/or cooled in order to achieve a gas density that is practical for the purpose. Such solutions have gained little practical use, but a solution in which a large number of vertical tubular pressure tanks are placed in the cargo hold of a ship, has attracted considerable attention. The method is termed PNG - Pressurised Natural Gas. According to such a method, the gas is compressed at the shipment location to an overpressure of a couple of hundred bars, and the gas then is filled onto the pressure tanks located on the ship. The cooling is limited to a simple and inexpensive removal of the gas compression heat, so as to leave the transport temperature near ambient temperature.

By installing relatively long cargo pressure tanks vertically in cassettes, it is possible to better exploit the material properties of the cargo pressure tanks, whereby the net weight of the cargo pressure tanks relative to the loading capacity of the ship may be reduced.

The object of the invention is to provide a device and a method for rational placing and connecting of the cassettes to the ship's cargo hold, and also to overcome weight-related constraints on the cassette construction with regard to lifting and secure fixing in the ship's cargo hold.

The object is achieved in accordance with the inventive features provided in the specification below and in the subsequent patent claims.

A number of cargo pressure tanks are placed on a cassette lifting frame prior to being lifted into the ship's cargo

hold. A guide frame is moved into the cargo pressure tanks to a position at the midsection of the cargo pressure tanks. The cargo pressure tanks, the cassette lifting frame and the guide frame constitute a cassette. The guide frame is arranged to mutually connect the cargo pressure tanks of the cassettes and to form a support member between the cassette and the ship's structure.

In the area between the cargo pressure tanks, the guide frame is provided with a through opening, through which a lifting yoke may be moved down to the cassette lifting frame. The lifting yoke is equipped with a locking device arranged to releasably engage the cassette lifting frame. , By means of a crane, the lifting yoke thus may be used to lift the cassette into or out of the ship's cargo hold.

The guide frame abutment face against the ship's structure may consist of a tapering portion that corresponds to a similar fixing section in the ship's cargo hold.

When the cassette is to be lifted into the cargo hold, the guide frame is placed in a position along the cargo pressure tanks causing the guide frame to bear against its corresponding fixing section during the lowering of the cassette into the cargo hold, and before the cassette lifting frame is disposed on the floor of the cargo hold. During the last stage of the lowering of the cassette into the cargo hold, the guide frame is moved along the cargo pressure tanks until the cassette lifting frame is placed onto the floor.

Thus the cassette is positioned correctly and connected to the ship's structure, inasmuch as it is placed on the floor

of the cargo hold. If required, more than one guide frame may be used for every cassette.

Then the lifting yoke is released from the cassette lifting frame and removed from the cassette.

The device and the method contribute to overcome the greatest disadvantage of the PNG-method, which involves the net weight of the cargo pressure tanks and the weight of the required fixing structure taking up too much of the loading capacity of the ship.

The cassettes are arranged for prefabrication, checking and certification before being positioned in the ship.

Preferably, the cargo pressure tanks of the cassette are connected to a joint manifold. As insignificant temperature difference and associated expansion may exist between the interconnected pressure tanks of the present structure, the manifold may be of a simple design.

A non-limiting example of a preferred embodiment is described in the following and is illustrated in the accompanying drawings, in which:

Figure 1 shows a cassette while being lowered into a cargo hold and just before the cassette guide frame bears against the fixing section of the ship, the remaining cassettes being placed in their transport positions in the ship's cargo hold;

Figure 2 is a plan view of the cassette;

Figure 3 shows a section II-II of figure 2;

Figure 4 shows, in larger scale, a section of the cassette lifting frame, in which the lifting yoke has been positioned in the cassette lifting frame and is ready for connection to the cassette lifting frame; and

Figure 5 shows the same as figure 4, but here the lifting yoke is lockingly engaging the cassette lifting frame.

In the drawings, reference number 1 denotes a cassette comprising cargo pressure tanks 2, a cassette lifting frame 4 and a guide frame 6.

The cassette is arranged for lifting into the cargo hold 14 of a ship 12 by means of a lifting yoke 8 and a crane 10.

The cargo hold 14 is constructed so as to allow a relatively large number of cassettes 1 to be placed in an upright position on the floor 16 of the cargo hold 14. At a level higher than the floor 16, the cargo hold 14 is provided with a fixing section 18 connected to the remaining structure of the ship 12 and arranged to take up horizontal forces from the cassettes 1.

The guide frame 6 encloses the cargo pressure tanks 2, as shown in figure 2, and is provided with a shoulder 19 or an inwardly sloping contact surface 20, see figure 1. The shoulder 19 or contact surface 20 correspond with equivalent surfaces 22 in the fixing section 18 of the ship 12. In the portion between the cargo pressure tanks 2, the guide frame 6

is provided with a through opening 24, through which the lifting yoke 8 may be moved.

The guide frame 6 is pre-tensioned and moveably connected to the cargo pressure tanks 2 in a manner not allowing its net weight to move it along the cargo pressure tanks 2.

The cassette lifting frame 4 is provided with appropriate abutment faces 25 for the cargo pressure tanks 2 and lifting brackets 26 in mating engagement with hooks 28 of the lifting yoke 8.

The hooks 28 of the lifting yoke 8 are pivotally connected to a lifting stay 30 of the lifting yoke 8 via pivot joints 32. A hydraulic cylinder 34, preferably remotely operated, is placed within, and one end portion thereof connected to, a housing 35 connected to the lower portion of the lifting stay 30. At its opposite portion, the piston rod of the hydraulic cylinder 34 is pivotally connected to the lower part of the hooks 28 via toggle joints 36.

When a cassette 1 is to be placed in the cargo hold 14 of a ship 12, a suitable number of cargo pressure tanks 2 are placed in an upright position on the cassette lifting frame 4, whereupon the guide frame 6 is moved along the cargo pressure tanks 2 until it is located at a suitable position at the midsection of the cargo pressure tanks 2.

The lifting yoke 8 is lowered between the vertical cargo pressure tanks 2 and onwards through the through opening 24 of the guide frame 6, the hydraulic cylinder 34 being in its turned-in position. The hooks 28 are in their retracted, inactive position, see figure 4. In this inactive position,

the hooks 28 may be moved past the lifting brackets 26 of the cassette lifting frame 4.

Then the hydraulic cylinder 34 is guided onto its extended position, whereby the hooks 28, by means of the toggle joints 36, are rotated about their respective pivot joints 32 to their turned-out, active position, see figure 5.

When the lifting yoke 8 then is moved upwards, the hooks 28 bear against the lifting brackets 26. The cassette 1 is lifted and then may be lowered into the ship's cargo hold.

During the lowering of the cassette 1 into the cargo hold 14, the exterior side faces 20 of the guide frame 6 bear against the corresponding surfaces 22 of the fixing section 18, whereby the cassette 1 is guided into the correct position relative to the fixing section 18. During the last lowering phase, the cargo pressure tanks 2 are moved down through the guide frame 6 until the cassette lifting frame 4 bears against the floor 16 of the cargo hold 14.

Thereby the cassette stands on the floor 16 and is fixed horizontally by the fixing section 18 via the guide frame 6 and any guides (not shown) connected to the floor 16.

The lifting yoke 8 is lowered further in order to relieve the hooks 28. The hydraulic cylinder 34 is operated so as to rotate the hooks 28 to their turned-in, inactive positions, whereupon the lifting yoke 8 may be lifted out of the cassette 1. Similarly, the cassette 1 may be lifted out of the ship for inspection, for example.

The hooks 28 may be formed with barbs (not shown) to prevent them from being pulled out of their engagements with the lifting brackets 26, even if the hydraulic cylinder 34 mistakenly is operated during the lifting operation when the cassette lifting frame 2 is placed in the lifting yoke 8.

If desirable, both the guide frame 6 and the cassette lifting frame 4 may be connected further to the ship's 12 structure.

Use of cassettes 1 according to the invention considerably simplifies, relative to the prior art, manufacturing, inspection and assembly of the present type of pressure tanks 2 of a ship 12.

C l a i m s

1. A device for fixing vertically installed cargo pressure tanks (2), in particular of the type used for sea transport of pressurised petroleum products, characterized in that at least two cargo pressure tanks (2) constitute a liftable cassette (1), the tanks (2) of which are placed preferably in an upright position on a cassette lifting frame (4) and being interconnected by means of a guide frame (6).
2. A device in accordance with claim 1, characterized in that the guide frame (6) is arranged to take up horizontal forces from the cargo pressure tanks (2) through abutment against a fixing section (18) in a cargo hold (14) of a ship (12).
3. A device in accordance with one or more of the preceding claims, characterized in that at least one contact surface (19, 20) of the guide frame (6) bearing against a corresponding contact surface (18) of the fixing section (18) is aslant relative to the longitudinal axis of the cassette (1).
4. A device in accordance with one or more of the preceding claims, characterized in that the cassette lifting frame (4) is provided with lifting brackets (26) that are in mating engagement with hooks (28) of a lifting yoke (8), the hooks (28) being connected to an actuator (34), the actuator (34) being arranged so as to allow it to move the hooks (28) between a locking and a non-locking position.

5. A device in accordance with one or more of the preceding claims, characterized in that the hooks 28 are formed so as to prevent them from being pulled out of their engagements with the lifting brackets (26) when the cassette lifting frame (1) is placed in the lifting yoke, even if the hydraulic cylinder (34) mistakenly is operated during the lifting operation.
6. A method of lifting a cassette (1) into a cargo hold (14) of a ship (12), characterized in that, during the lowering of the cassette (1) into the cargo hold (14), the guide frame (6) bears against the fixing section (18) before the cassette lifting frame (4) bears against the floor (16).

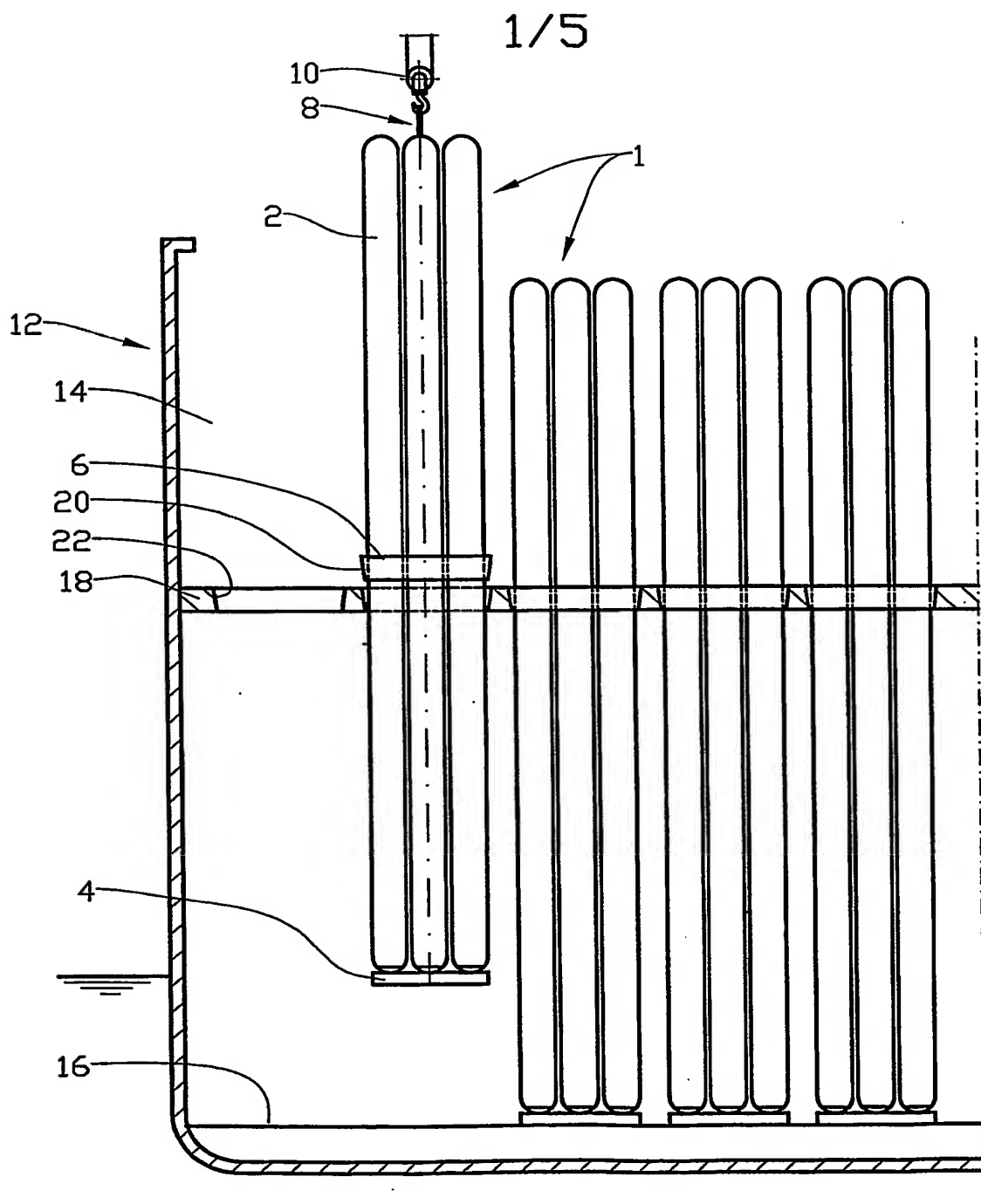


Fig. 1

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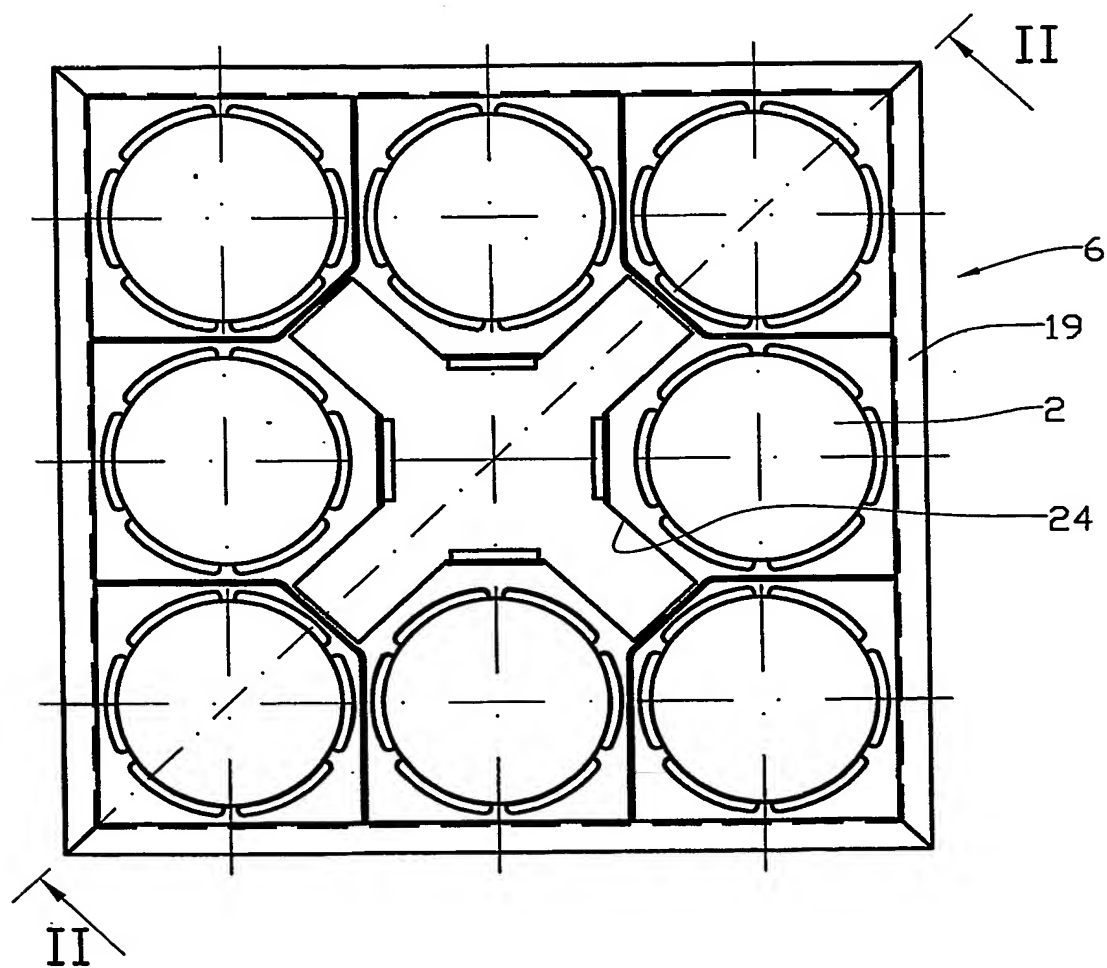
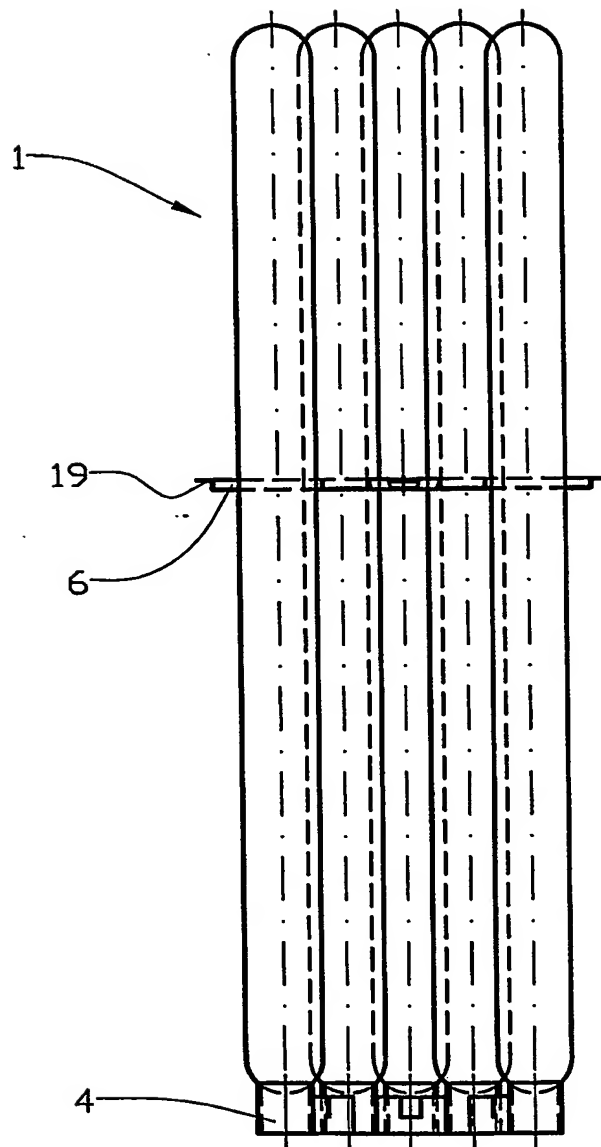


Fig. 2

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II-II

Fig. 3

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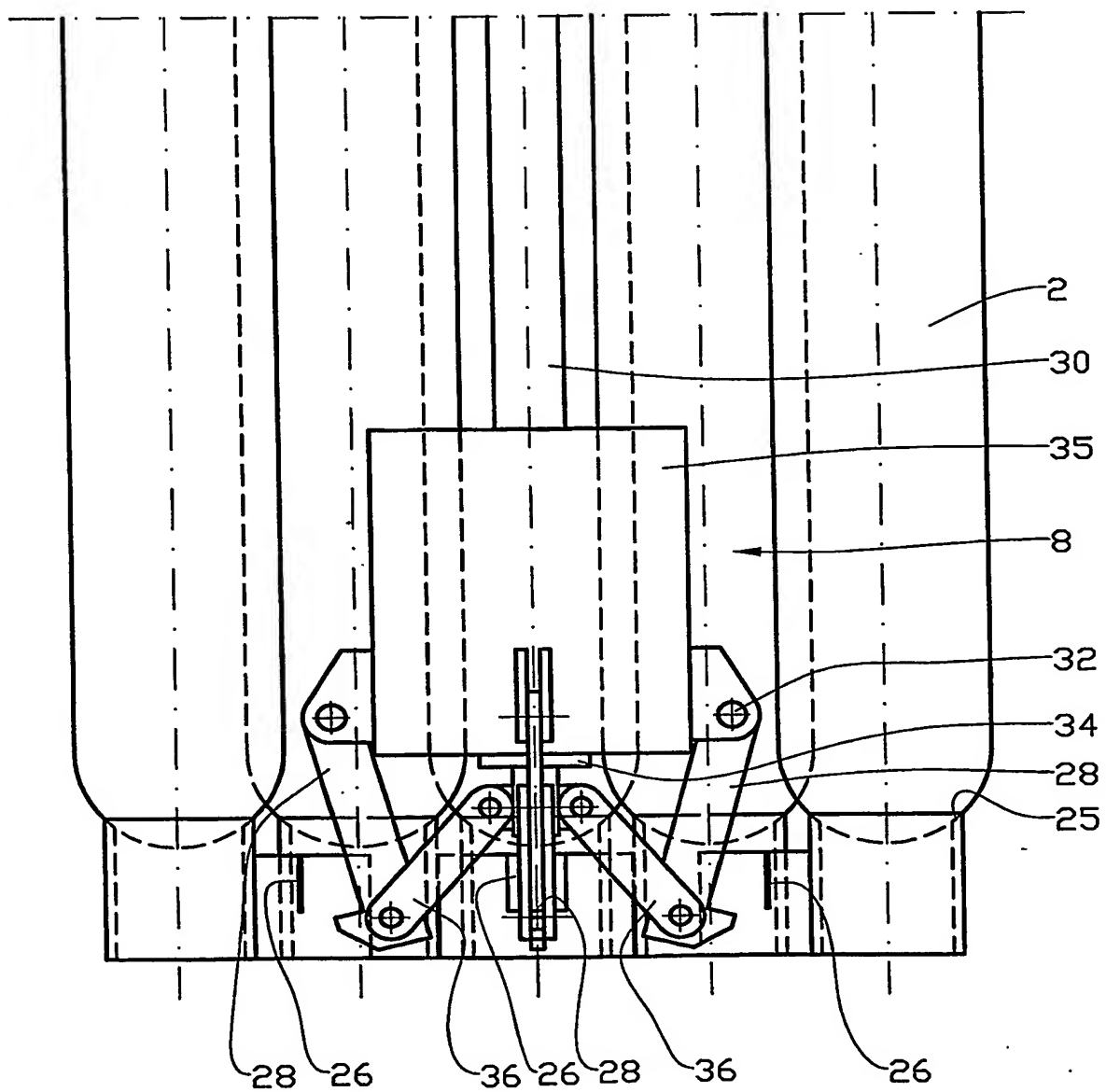


Fig. 4

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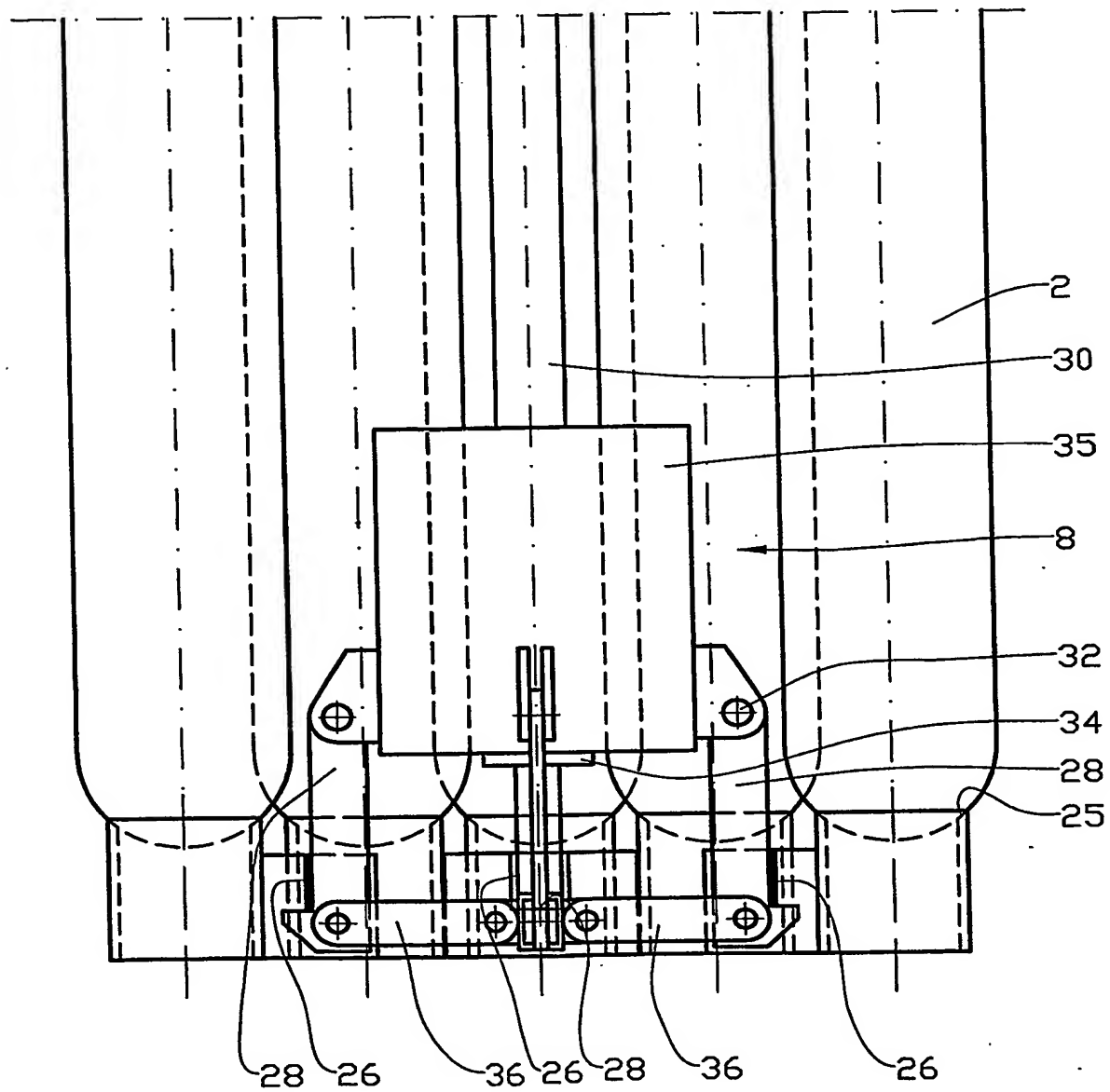


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 03/00217

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F17C 13/08 // B63B 25/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F17C, B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2536373 A1 (RIVE-DE-GIER, SFR ET AL), 25 May 1984 (25.05.84), figures 5-12,16, abstract	1
Y	--	4,5
X	US 4564109 A (L.G. STAVLO), 14 January 1986 (14.01.86), figures 1,2, abstract	1
X	US 4967934 A (M.D. ANDONIAN), 6 November 1990 (06.11.90), figures 1-3, abstract	1
Y	US 2002084660 A1 (J. WEBBER), 4 July 2002 (04.07.02), whole document	4,5
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☒ See patent family annex.

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PCT/NO 03/00217

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 02066316 A1 (KNUTSEN OAS SHIPPING AS), 29 August 2002 (29.08.02), whole document --	1,2,6
P,X	WO 03047959 A1 (KNUTSEN OAS SHIPPING AS), 12 June 2003 (12.06.03), whole document --	1,2,6
P,A	WO 03016777 A1 (SIDA ENGINEERING-S.R.L.), 27 February 2003 (27.02.03), whole document -- -----	1-6

INTERNATIONAL SEARCH REPORT
Information on patent family members

26/07/03

International application No.
PCT/NO 03/00217

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
FR	2536373	A1	25/05/84	NONE		
US	4564109	A	14/01/86	NONE		
US	4967934	A	06/11/90	NONE		
US	2002084660	A1	04/07/02	US	6439632 B	27/08/02
WO	02066316	A1	29/08/02	NO	313846 B	09/12/02
				NO	20010728 A	14/08/02
WO	03047959	A1	12/06/03	NO	20015962 D	00/00/00
WO	03016777	A1	27/02/03	IT	MC20010086 A	20/02/03

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